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Development on Smart Suit for Dairy Work Assistance

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Abstract— **Our purpose in this study is to achieve an independent life and a social involvement for the elderly using KEIROKA Technology(fatigue-reduction) which makes it possible to improve the quality of chores and occupations by removing excessive strain and tiredness. The authors have developed power assist suits named "smart suit". The authors have evaluated the effect that the purpose of dairy work assistance, to measure EMG of the worker, compared to the potential of the surface of the non-wearing and wearing "smart suit".**

I. Introduction

In Japan's aged society, it is necessary to establish a basic social system in which younger persons multilaterally support older persons. But, it's an extremely difficult to be established as community structure just by that system at the thought of current population composition. So, it's necessary that the elderly lives an independent life according to his/her own ability.

Furthermore, it's also important that the elderly lives worthwhile days to enhance his/her quality of life. Hence, techniques that enable them to live and work with energy in aged society can be responsive to the issues such as the decrease in working populations, the increase in social security costs and participation in society by the elderly.

Accordingly, we aim to achieve an independent life and a social involvement for the elderly using KEIROKA (fatigue-reduction) Technology which makes it possible to improve the quality of their chore and occupation by removing excessive strain and tiredness. In addition, we advocate 3S Assistive KEIROKA Technology which reconsiders the value of products made by the hands and supports daily operations with Secure, Sustainable and Subliminal.

This concept is intended to alleviate human fatigue and maintain human body function, that is to say, not only to prevent the physical function from weakening with accumulate fatigue by removing excessive tiredness, but to maintain body function such as geriatric muscles strong to make task supports possible. In this way, it is thought that the elderly can participate in social involvement and lives well in grayer society.

Moreover, it would appear that enhancing 3S Assistive KEIROKA Technology according to the individual level of body function, which make it possible to support their daily life chores, can be applied to support of the elderly who is infirm or disabled. Therefore, it's believed that this technology can help to improve the quality of life and reduce care burden.

Additionally, there are not just elderly people but many young people who need assistive technology to lighten workload. However, excessive supports result in the muscular depression and the loss of sensory function. What is more, they are associated with a risk of premature senescence and atrophy in physical functions. Hence, an assistive technology tailored to individual physical ability is necessary. However, there is no established standard for architectonics and assessments to develop the assistive system and technology itself.

Before now, although various assistive technologies for work and task supports like POWER SUIT and a force-multiplication device were proposed, they are used for evaluations of short-term effects and technology designs and their assessments in a long-term standpoint are not performed[1].

We have developed two kinds of KEIROKA Technology in the past. First, there is SMART SUIT which is human-friendly wearable muscle assist system and supports a half-crouching position and anterior bending motion during agricultural work. The other is a universal design(UD) shovel designed for removing snow without forced forward-bending position. The former one is defined as wearable KEIROKA Technology. The latter one is defined as KEIROKA Technology improved apparatus. It confirmed that both equipments achieved some positive results.

Especially pertaining to UD shovels, we performed experiments in which 42 subjects continued to remove snow using UD shovels for six weeks, and investigation was conducted about change of basic physical fitness and so on[2]. However, evaluation index and system to objectively and quantitatively judge effectiveness of KEIROKA Technology from viewpoint of bioengineering, for example, evaluation such as physical load, assistant effect of muscle, analysis method for alleviating fatigue and attitude stability are not established yet.

To get used to the operator dairy to use "smart suit" was newly developed for the purpose into labor light to conduct experiments with the purpose of work assistance dairy, in this

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study, the surface of the work where I measured the EMG. And I was to evaluate the effect by comparing the potential of the surface of the non-wearing and wearing a smart suit.

II. SMART SUIT ACTUAL FIELD TEST

Specifications are shown in Table 1 and Figure 1 for auxiliary smart suit developed by the three-dimensional behavior. As three-dimensional motion, also consider the behavior of the trunk twist waist in addition to bending motion. By winding the belt which is connected to the elastic material of the shoulder at the two actuators, independent control of the fixed point of the elastic member disposed on the back cloth.

Be useful, the suit into labor light passive rotation elastic material behavior also placed in addition to the cross-bending motion: design already has been analyzed elastic material properties of light in a smart suit [2].

In addition, the difference in the rate of change of the two bend sensor located at the hip joint, and also enables detection of the twist of the trunk as well as the bending operation. It is not a smart suit auxiliary operation into semi-active three-dimensional elastic material disposed cross made it possible to flexibly adjust the assist force target a variety of tasks.

Fig. 1: Smart suit for 3-dimensional assist

Table. 1: Specification of old and new smart suit

Target motion	Bending & twisting of upper body
Sensor	2 bend sensors & 2 accelerometers
Actuators	2 actuators (20[W] each)
Assist force	26[N/unit] (@ 20% output)
Weight	1.5[kg] (w/o Batt.)
Battery	12[V] (800[g])

III. ASSIST EFFECT EXPERIMENT FOR DAIRY OPERATION

A. *Experimental Method*

We were measured using a surface EMG muscle and so reduce the burden caused by the presence or absence of smart suits milking operation. Three times, and the number of attempts is there no smart suit smart suit was measured four times. Taking the average value of each section to be described later, respectively, and their ratio rate burden.

(a) Erector Spinae Muscle

(b) Hamstrings

(c) Quadriceps Muscle

Fig. 2: Part of the measured EMG

Table. 2: Analysis result

Analysis section [s]	Erector Spinae Muscle(Right)	Erector Spinae Muscle(Left)	Hamstrings	Quadriceps Muscle
0～5	24.9	31.9	21.8	-7.3
5～10	30.2	11.4	3.6	13.7
10～20	-26.2	-17.9	27.6	10.2
20～30	-48.7	-21.1	-12.6	84.3
0～30 (All)	-18.3	-10.0	10.4	71.4

B. *Experimental Results*

The Second half (10-20 seconds, 20-30 seconds) is analyzed separately in the first half (0-5 seconds, 5-10 seconds) and. The first half is the main upright posture, attitude is mainly the second half crouch.

<First half>
0-5 seconds : Walk to the cow with the milker.
5-10 seconds : After preparing crouch start working milker (kneeling position).

<Second half>
10-20 seconds : Attached to the cow milker crouching.
20-30 seconds : Rose from the crouch, stop measuring device.

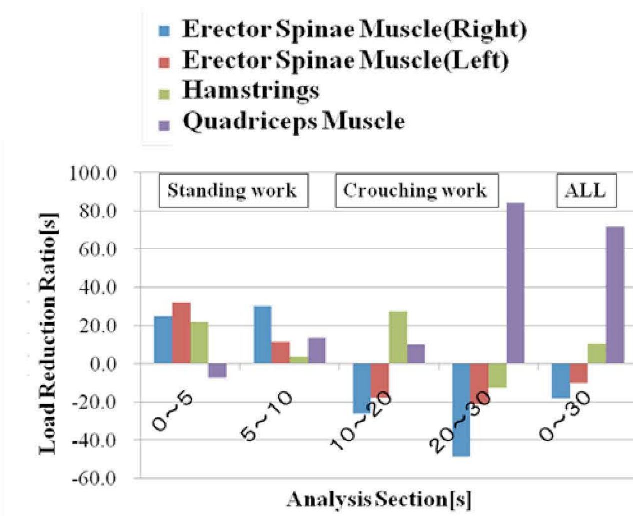
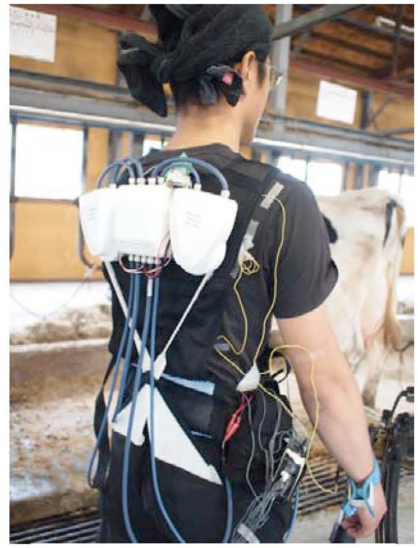


Fig. 3: Analysis of EMG

Table 2 and Figure 3 shows the results of each analysis period. Exert maximum muscle force to reduce the burden rate for each site and each measurement interval analysis in Table 2 is (%). Figure 3 in which the horizontal axis of each analysis period, and the vertical axis is represented in the graph as a burden rate (%) based on Table 2.

Milker is almost ready for operation and the behavior of upright walking, the behavior of the first half, this period effect was observed to reduce the burden of the erector spinae is eligible for subsidies.

Is a full squat behavior, the behavior of the second half, the erector spinae muscles showed an increase in the burden on this interval. On the other hand, the burden of the quadriceps muscle is greatly reduced. Behavior is a behavior not covered by aid of a smart suit newly developed, to assist in erector spinae and it was not be because they loosen the elastic material crouch, elastic material of the thigh is to reduce the burden of the quadriceps I think you have contributed to.



(a) Smart Suit for Dairy Work

(b) Photo of the experiment

Fig. 4: Field test of Smart Suit for Dairy Work Assistance

IV. Conclusion

To develop a smart suit was aimed at making labor light, we cooperate with dairy workers, we have to measure the potential of the surface of the work. Then, as a result of evaluating the effect by comparing the potential of the surface of the non-wearing and wearing a smart suit, effects were seen, such as reducing the burden of erector spinae is eligible for subsidies.

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